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(54) Title: Method for Fabrication of Light-Core Composite Boards and Light-Core Composite Constructions from Plastic Foam Materials

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Method for Fabrication of Light-Core Composite Boards and Light-Core Composite Constructions from Plastic Foam Materials

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The invention concerns a method for the fabrication of light-core composite boards and light-core composite constructions from plastic foam materials, preferably based on polyurethane. Light-core composite boards are known, being fabricated in layering processes, wherein foam sheets cut to size have surface layers glued onto them. Moreover, it is known how to fabricate such light-core composite boards by the foam-up method, wherein hollow prefabricated bodies are filled up with the expandable mass. In all these familiar methods there is no intimate connection between the outer surface layers and the core. Also, the naturally costly use of additional adhesives is not satisfactory in practice.

The drawbacks of the known techniques are eliminated by the invention in that one places into a mold, preferably cooled down to 8-12°, at first a bottom layer of a not yet fully reacted liquid foam mixture of high final density, e.g., 0.2 g/cm^3, and then a fully expanded harder core of a foam material of lesser final density, e.g., 0.01-0.08 g/cm^3, and onto this core one places a second surface layer of the first-mentioned foam material, whereupon after the mold is closed and pressure applied, the surface layers expand in conjunction with a densification of the layers adjacent to the walls of the mold, making use of the heat of the reaction.

According to an earlier proposal for the fabrication of light molded objects with densities of 0.2-0.9 from plastic foam material, in which the crude foam molding formed in the pre-mold is placed in a final mold before the ending of the reaction of the components that produces the cross-linking, and in this final mold the reaction is terminated, along with the final molding and densification of the foam body, making use of the heat of the reaction occurring during the fabrication of the molded construction, the expansion of the crude foam molding occurs in a foam pre-form preferably cooled to below 10°. As compared to this older method, the method of the invention offers the advantage of producing an extremely light core with a highly compacted surface layer. If one were to place a foam mixture with 0.02 g/cm^3 free foam density into the mold and mold it, the core would also be compacted. Although this compacting of the core is by far less intense than the compacting of the outer zone, even so this technique would not be profitable in the fabrication of composite boards, since so light a raw material batch would require an extremely large filling space and, thus, correspondingly large molds. Another major advantage over the known method is the much shorter time for curing of the relatively thin surface layers, since the core is already in its final expanded state.

In another embodiment of the invention, the core can have smaller side dimensions than the mold, so that the surface layers reach around at the sides, serving as edging strips and encasing the core all around. One thus obtains a body having a closed surface on the outside and a light filler core on the inside. The connection between the surface layers and the core is especially intimate, since the still reactive foam mixture penetrates into the pores of the already reacted core and the surface layer and core mesh together, so to speak.

The thickness of the core and the surface layers can be varied howsoever desired, depending on the thermal or mechanical requirements. Of course, it is also possible to have a surface layer on only one side. One can also embed or layer semi-hard and soft foam materials on one or both sides. Fabric, braiding, paper, wire, glass fiber, fiberglass mats, etc., can also be placed inside as a core layer or in addition to a specifically light core. Moreover, a decorative layer of colored plastics, metals, wood veneer, etc., can be placed on the surface layer in a single work step, without the use of glue. This method, furthermore, is not confined to the fabrication of sheet-like objects. One can make molded pieces of any desired shape, as long as the light core is surrounded by a surface layer, e.g., spherical segments for construction of domes, pipes, etc. The various possibilities of processing and choice of shapes result in correspondingly many fields of application. Depending on the use, the surface layer can also be made semi-hard or soft by modifying the formula.

The benefit of the new method consists primarily in that the glue problem solves itself. Moreover, it is not required to place any side edging strips on the finished body in an additional work step, since the core is surrounded on all sides, i.e., also at the edges, by the surface layer. As compared to the foam-up method, neither are any costly support molds necessary. Another benefit over all previous composite construction methods using a foam material as core is that the core and the surface layer consist of the same raw material in the new method. This means that core and surface layer have approximately the same coefficient of thermal expansion and therefore the danger of warping under temperature stress is largely eliminated.

Example:

Into a closeable mold, whose interior can be placed under pressure, a liquid foam mixture consisting of components A and B with a high final density, such as 0.2 g/cm^3, is placed. The components have the following composition:

Component A:	24.5 g Ricinus oil	[handwritten notes illegible] (prepolymer)
	37.2 g Desmodur T 65	
Component B:	25.0 g Ricinus oil	
	12.3 g Quadrol (N, N, N; N; - tetrakis 2-hydroxypropyl ethylene diamine)	

0.5 g Activator 726 b (hexahydrodimethylaniline)
0.5 g Additive SM (sultafone oil)
4 drops T 9 (tin-II-octoate)

These two components, owing to their runny consistency, can be mixed very well and blended with a 2000 rpm agitator. The mixing time can easily be adjusted by varying the T 9.

This mixture should have swollen up and already have set at the surface before being placed into the mold. A very light, already fully cured board cut to size, e.g., one made from polyurethane foam (0.01 to 0.08 g/cm^3), Styropor, PVC foam, or the like, or a layer of cellulose-based fiberboard, wood chip board, such as particle board, etc., is then placed onto this still reacting foam material. Then another liquid mixture of foam material of the above-mentioned composition is placed in the mold on top of this, after which the mold is closed and placed under pressure. The reaction then completes itself, utilizing the natural heat of reaction of the mixture, inside the mold. One obtains a body having a closed surface on the outside and a light core of foam material or any desired light material on the inside, while the connection between surface layer and core is complete without the use of adhesives.

In another embodiment of the idea of the invention, the light-core composite sheets can also be produced in endless manner, by placing the surface layers continuously on both sides of the constantly advancing core layer and immediately thereafter performing a pressing between moving molds without supplying heat.

A suitable device for carrying out the method is characterized according to the invention by two endless conveyor belts, arranged one above the other with a spacing, being placed under pressure on their surface, onto or between which are fed in sequence first the bottom surface layer, then the core layer, and finally the top surface layer, wherein the lower conveyor belt is slightly longer than the upper conveyor belt and juts out accordingly in order to facilitate the feeding.

Patent Claims

1. Method for fabrication of light-core composite boards and light-core composite constructions from plastic foam material, preferably based on polyurethane, characterized in that one first places, into a mold preferably cooled to 8-12°, a surface layer of a liquid mixture of foam material of high final density, and then before the reaction is completed one introduces a fully expanded hard, semi-hard, or soft core of a foam material of lesser final density or a similar specifically light material, and on this core one places a second surface layer of the first-mentioned foam material, while after the mold is closed and pressure is applied, the expansion of the surface layers occurs in conjunction with a densification of the layers next to the mold walls, making use of the heat of the reaction.

2. Method per Claim 1, characterized in that the core has smaller side dimensions than the mold, so that the surface layers reach around at the sides and encase the core all around.

3. Method per Claim 1, characterized in that one uses for the surface layers and/or the core a foam material produced by reaction of an isocyanate with one or more substances containing OH groups, such as Ricinus oil, N, N, N; N; - tetrakis (2-hydroxylpropyl) ethylene diamine, natural compounds, unsaturated compounds or similar mixtures or derivatives thereof.

4. Method per Claim 1, characterized in that the surface layers are provided with a decorative layer of colored plastics, metals, wood veneer, etc., in a single work step.

5. Method per Claim 1, characterized in that fabric, braiding, paper, wire, glass fiber, fiberglass mats, etc., are inserted, possibly omitting the foam core.

6. Method per Claim 1, characterized in that the surface layers are applied continuously to both sides of the constantly advancing core layer and immediately thereafter the layers are subjected to pressing between moving molds, without supply of heat.

7. Device to carry out the method of Claim 6, characterized by two endless conveyor belts arranged one above the other with a spacing, placed under pressure on their surface, onto or between which one feeds in sequence first the bottom surface layer, then the core layer, and finally the top surface layer, while the lower conveyor belt is slightly longer than the upper conveyor belt to facilitate the feeding.